

1951



2004



Prepared for:
The Town of Hilton Head Island

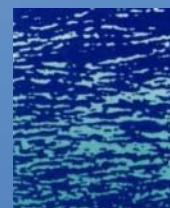
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December 2006

Lands End Groin Study

Sea Pines Resort

Hilton Head Island, South Carolina



olsen

Sea Pines Plantation, Hilton Head Island, South Carolina

Lands End Groin Study

1.0 SCOPE & AUTHORIZATION OF STUDY

This engineering report summarizes the findings of a historical shoreline change analyses and an engineering alternatives analysis for the existing Lands End groin. This report was prepared for the Town of Hilton Head Island and addresses the following:

- Physical site characteristics (including astronomical tides and tidal datums),
- Existing conditions at the Lands End Groin site,
- Historical shoreline change,
- Recommended engineering alternatives for groin modifications/improvements (including probable costs to construct),
- Anticipated effect of engineering alternatives on up- and down-drift shorelines.

This study was commissioned at the direction of the Town of Hilton Head Island Town Council.

2.0 PHYSICAL SITE CHARACTERISTICS

The Lands End Groin is located within the Sea Pines Development at the southern end of Hilton Head Island, South Carolina (**Figure 2.1**). The structure is situated along the southeastern shoreline of Calibogue Sound, immediately south of the entrance to Braddock Cove Creek, (**Photo 2.1**). The tidal datums at the Braddock Point tidal station are listed in **Table 2.1** and the station location is shown in Figure 2.1. The tides at the station are semi-diurnal and have mean and spring ranges of about 6.74 ft and 7.82 ft, respectively.

Table 2.1: Tidal datums at NOS station 8669625 (Braddock Point, Hilton Head, SC).

Datum	Elevation (ft-NGVD)
Mean Higher High Water (MHHW)	4.14
Mean High Water Line (MHWL)	3.77
Mean Tide Level (MTL)	0.40
National Geodetic Vertical Datum of 1929 (NGVD)	0.00
Mean Low Water Line (MLWL)	-2.97
Mean Lower Low Water (MLLW)	-3.19

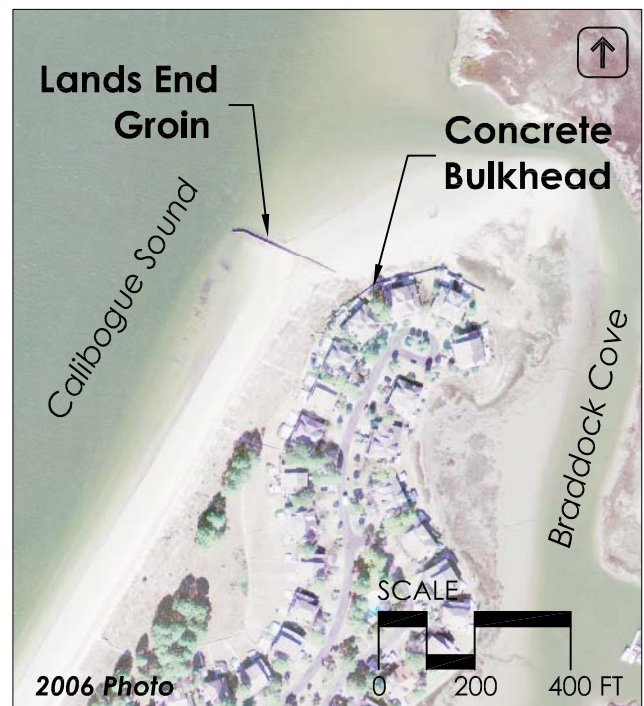
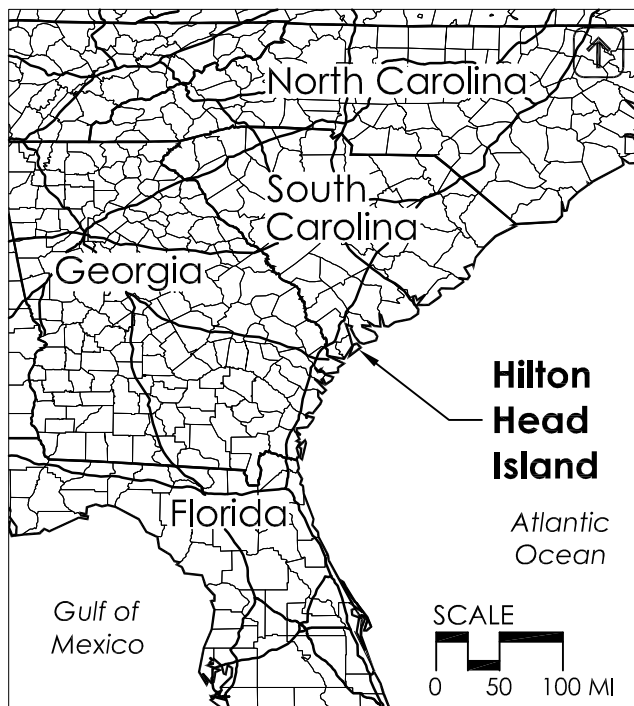
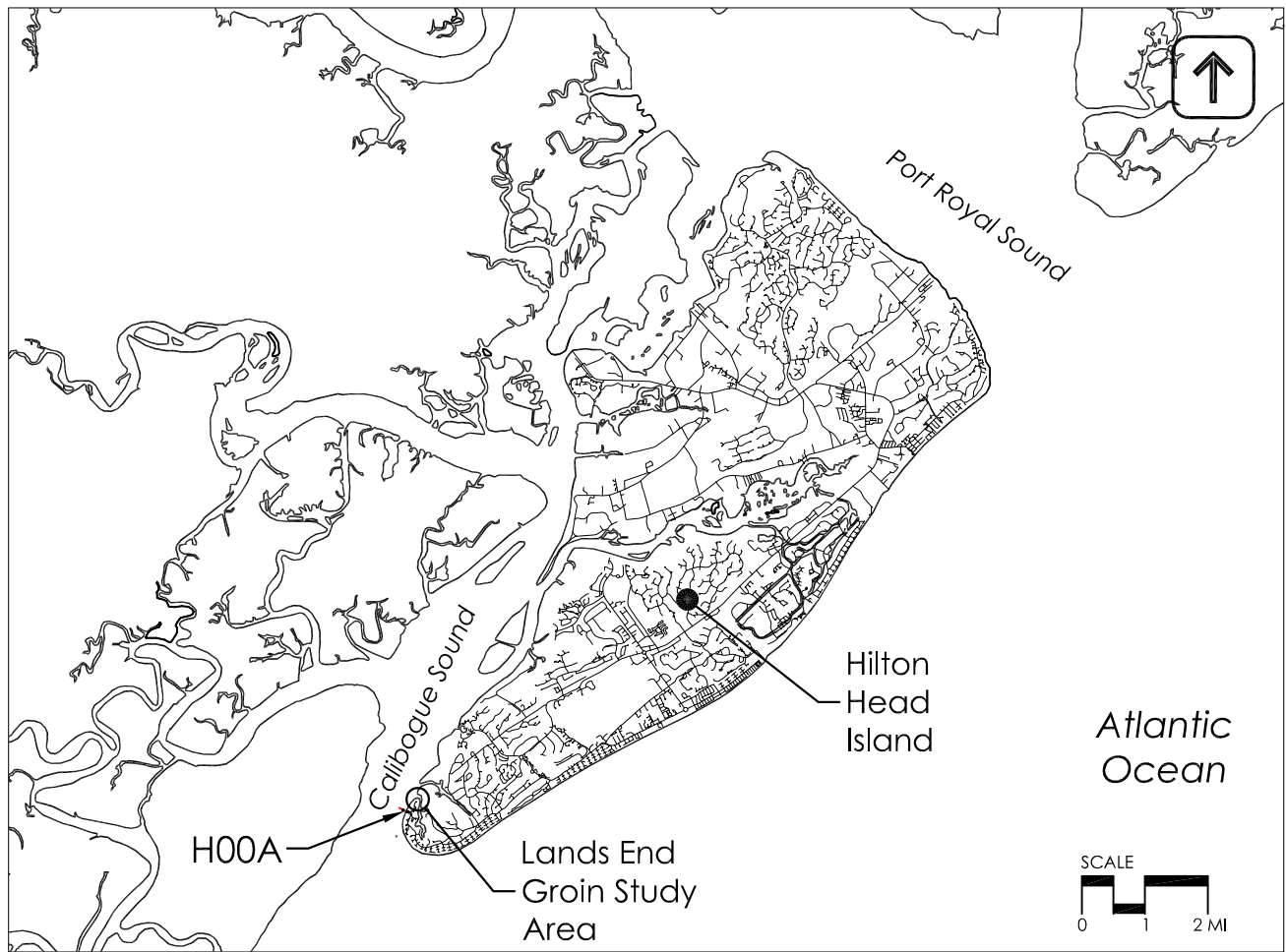


Figure 2.1: Study area location map, Hilton Head Island, South Carolina.



Photo 2.1: February 2004 aerial photo of Land's End Groin site, Hilton Head Island, S.C. (Photo Courtesy of the Town of Hilton Head Island).

3.0 EXISTING GROIN CONDITION

The Lands End groin presently extends roughly 300 feet seaward from the base of a concrete bulkhead and approximately 120 feet beyond the existing MHWL. The structure consists of thirty (30) concrete king piles spaced roughly 10 feet apart. The piles are spanned by a series of timber planks. The timbers fit into the mortise running the length of each pile and are held in place by wooden chocks that are thru-bolted to the pilings (**Photo 3.1**). The pile crest elevations vary from 7.4 ft-NGVD at the first pile (most landward) to 2.3 ft-NGVD near the seaward end of the structure. The top of the spanning timbers is typically situated 1.0 to 1.5 ft below the crest of the piles. **Figure 3.1** depicts plan and section views of the existing structure. The existing bathymetry and topography in the vicinity of the structure are plotted as **Figure 3.2** (based upon an October 2006 HIS survey and a February 2002 LIDAR survey).

The precise construction date of the Lands End groin is uncertain. Review of the available historical aerial photography suggests that the groin must have been constructed between September 1975 and October 1979, as it is not present in the 1975 photograph but is present in 1979 (copies of these aerial photographs are provided in **Appendix A**).

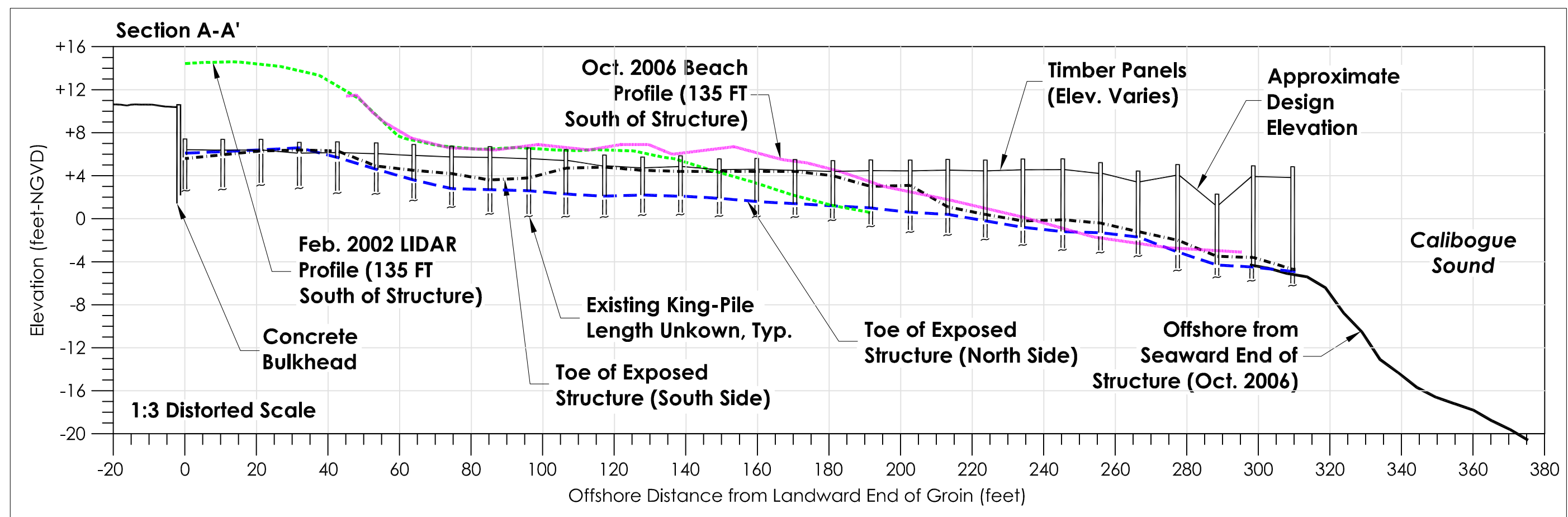
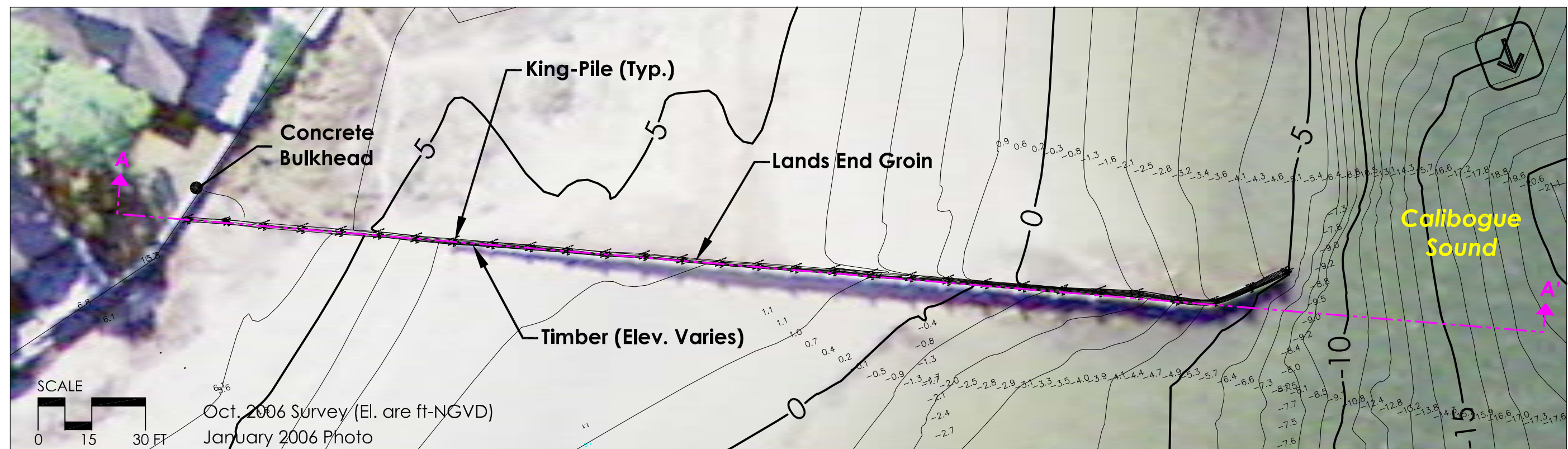


Figure 3.1: Plan and section views of Lands End groin.

Seabed
Elevation
(ft-NGVD)

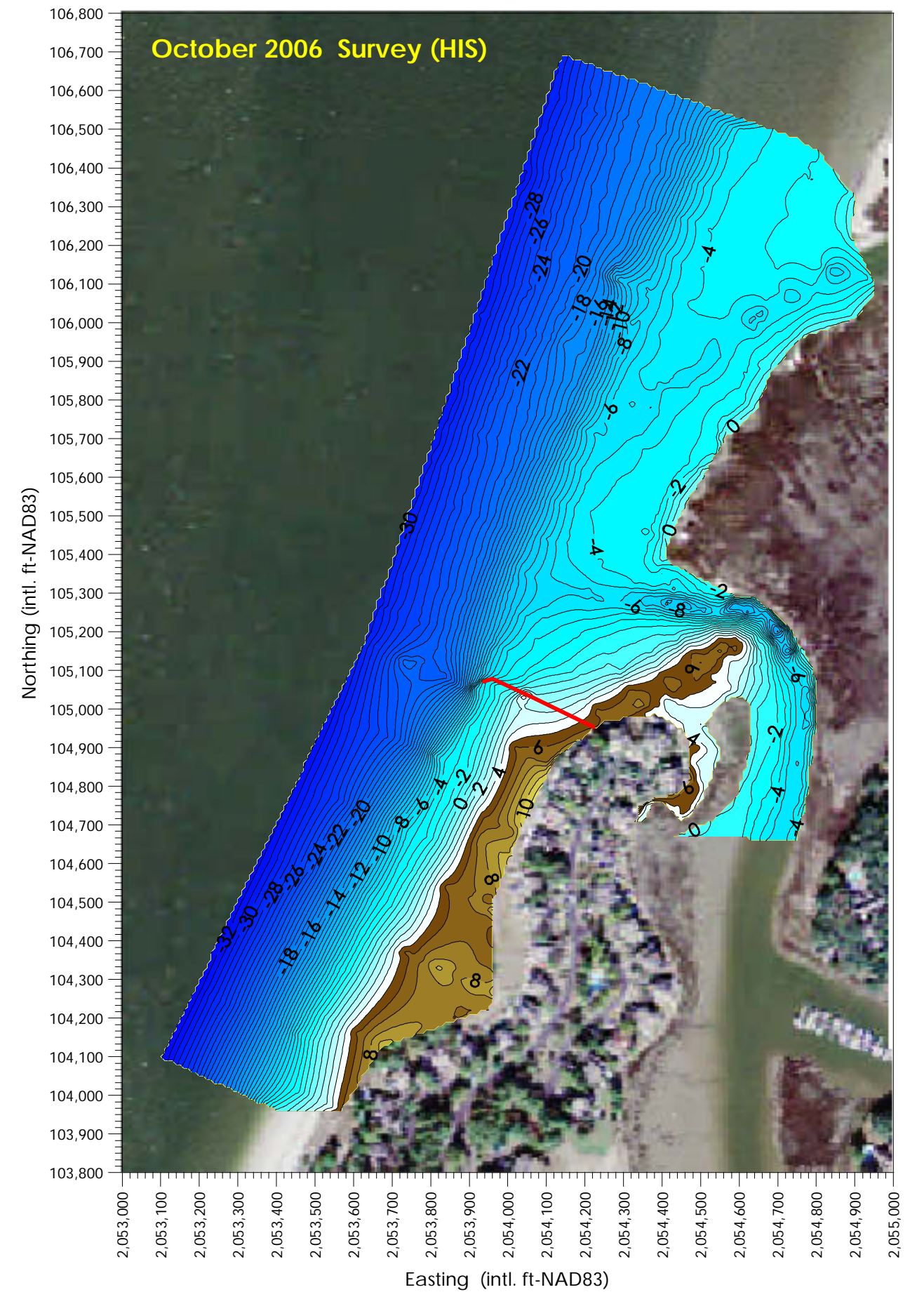
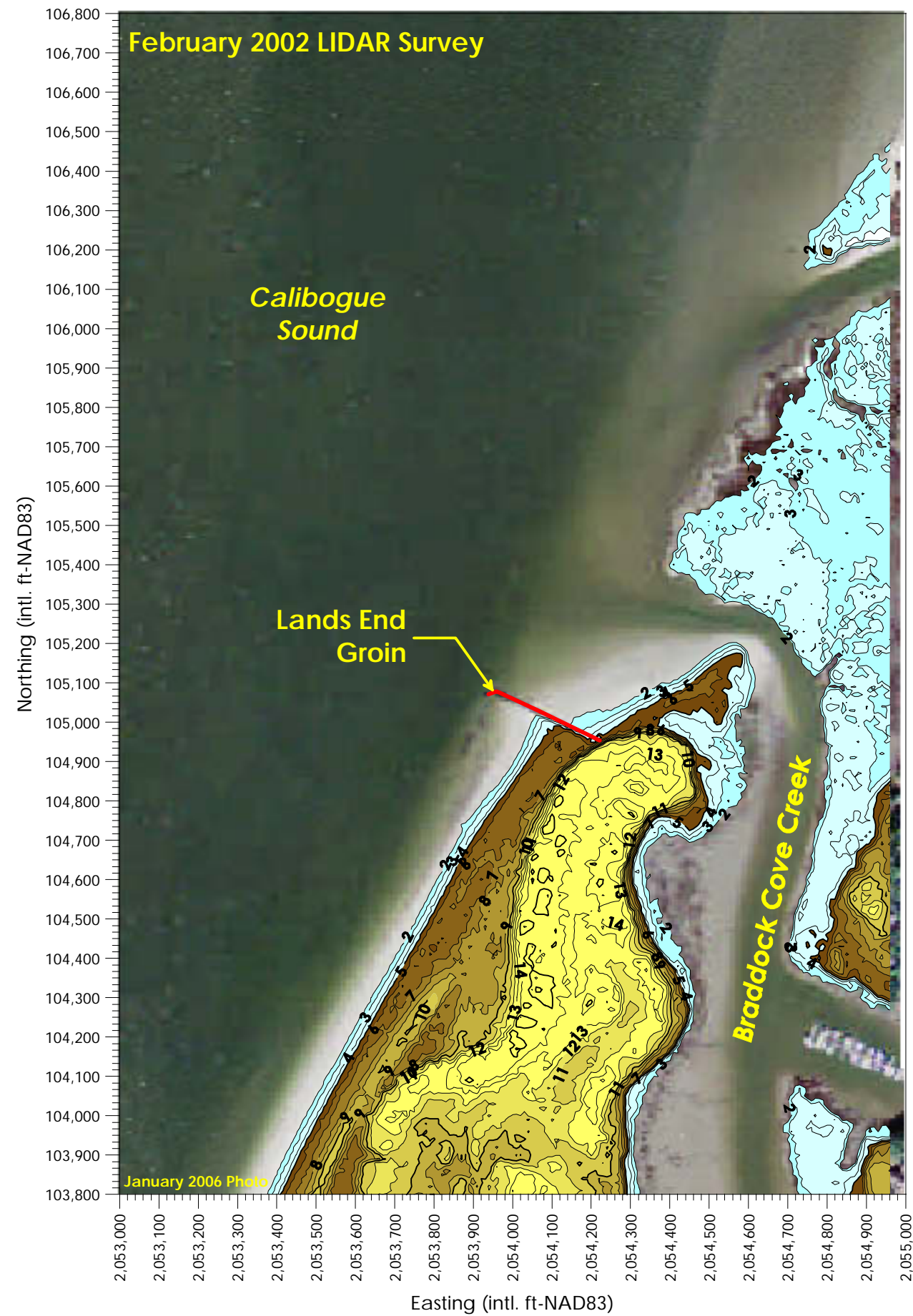
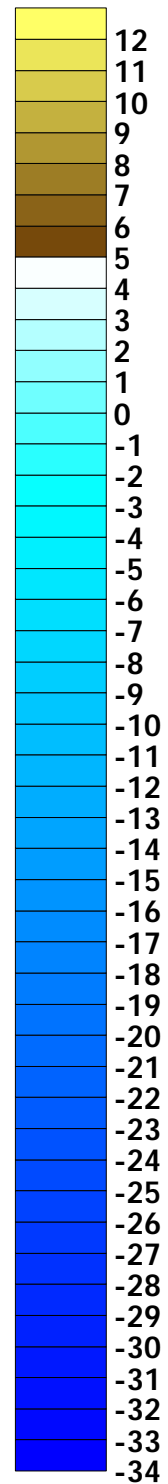


Figure 3.2: February 2002 and October 2006 surveys at the Lands End Groin.



Photo 3.1: Photo showing intact pile/timber/chock structures

In the roughly 30 years since the groin was constructed, the structure has deteriorated to the point that it is no longer functioning as originally intended. Anecdotal information obtained through this investigation from Community Services Associates (CSA) suggests that some timbers and chocks were replaced in 2002-03. However, this action does not appear to have significantly altered the function of the structure. As of 2006, several of the wooden chocks are damaged or missing, resulting in the vertical movement of spanning timbers during the tide cycle (**Photo 3.2**). The groin is not sand-tight and therefore is not a highly effective sand retention structure (**Photo 3.3**). Evidence of the porous nature of the structure is the large sand spit along the southern bank of the Braddock Cove Creek entrance (Photo 2.1). However, even if the groin was made sand-tight to the original design elevation¹, sand transport over the structure would continue during storms and elevated tidal conditions. In Figure 3.1, a beach profile located approximately 135 ft south of the structure is plotted along with the presumed design elevation of the structure. Note that along the upland portion of the beach (above +4 ft), the Oct. 2006 surveyed beach profile is typically 0 to 5 feet above the original design elevation of the groin.

¹ The original design grade is assumed to be approximately 1 foot below the top of the king-piles along any given section of the groin.

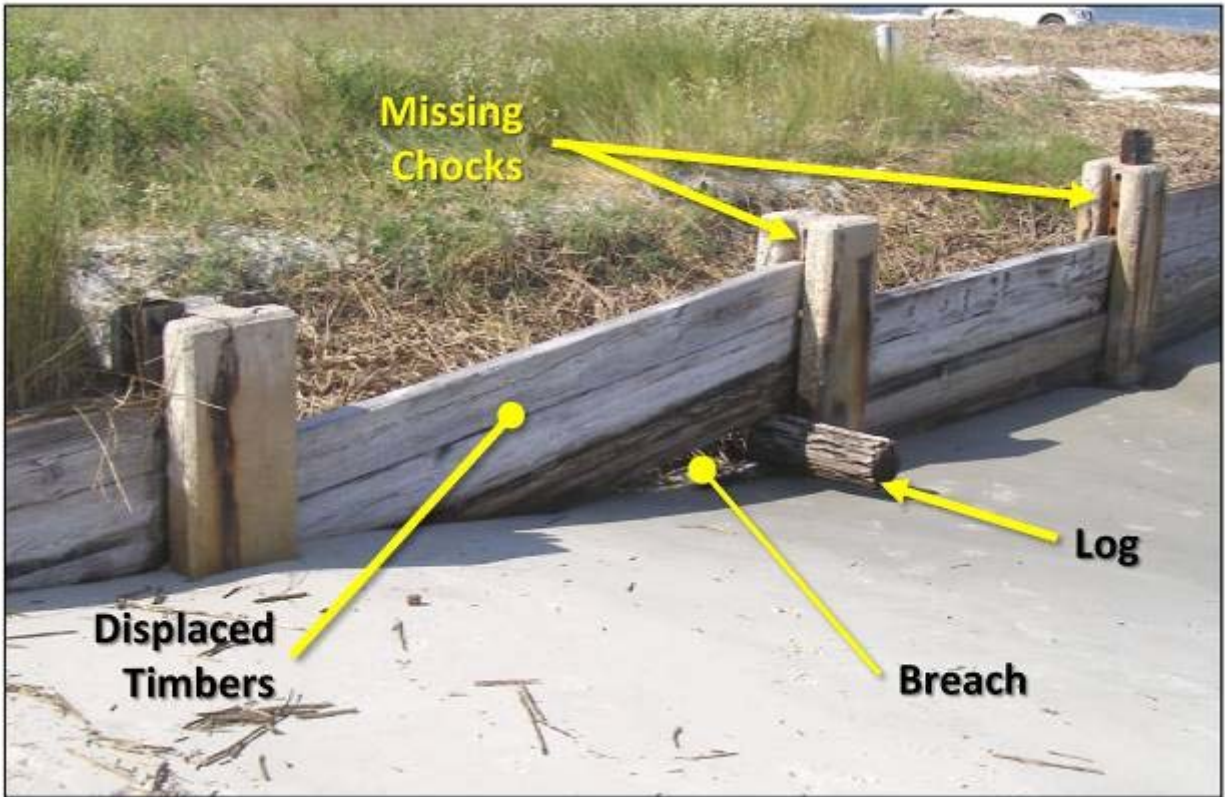


Photo 3.2: Photo (Sept. 2006) showing damaged pile/timber/chock structures and resulting breach.



Photo 3.3: Scour hole formation resulting from sand and water movement through the structure. Note: Photo taken at low tide conditions (Sept, 2006).

4.0 SHORELINE HISTORY

4.1 Shoreline Data

A shoreline change analysis was conducted using historical aerial photography. The photography used in the analysis was obtained from the U.S. Department of Agriculture (USDA), the Town of Hilton Head Island and Beaufort County, South Carolina. The aerial photography collected for this study is summarized in **Table 3.1** and provided in **Appendix A**. In reviewing the photography, the reader should be aware that the tide stages vary significantly between photographs.

A detailed, study specific topographic/hydrographic survey was performed in October 2006 by HIS, Inc.² Additionally, a February 2002 LIDAR topographic survey provided by Beaufort County was used in this investigation as well as the Town's historical beach monitoring surveys at station H00A, located approximately 1,150 ft south of the Lands End groin (Figure 2.1).

Table 3.1: Available historic aerial photography for the Lands End Groin site.

Date	Source	Description
February 1951	USDA	Scanned
January 1955	USDA	Scanned
November 1959	USDA	Scanned
January 1965	USDA	Scanned
March 1972	USDA	Scanned
September 1975	USDA	Scanned
October 1979	USDA	Scanned
January 1983	Town	Scanned
October 1987	Town	Scanned
March 1989	Town	Scanned
March 1995	Town	Digital & Rectified
August 1996	Town	Scanned
April 1997	Town	Scanned
January 1998	Town	Scanned
November 1998	Town	Scanned
January 1999	County	Digital & Rectified
March 1999	Town	Scanned
September 1999	Town	Scanned
October 2000	Town	Scanned
September 2001	Town	Scanned
February 2002	County	Digital & Rectified
December 2002	Town	Scanned
December 2003	Town	Digital & Rectified
January 2005	Town	Digital & Rectified
January 2006	County	Digital & Rectified

² Hydrographic Information Services, Inc.; 7033 Commonwealth Ave., Ste. 8; Jacksonville, FL 32220

4.2 Shoreline Change Analysis

The purpose of this analysis is to document the historical shoreline conditions, both pre- and post-construction of the Lands End groin, in an attempt to develop an understanding of the littoral sediment transport patterns at the study site. **Figures 4.1** through **4.4** depict the shoreline positions digitized from the 1951 through 2006 aerial photographs. To document the long-term change trends, the shoreline is represented as both the approximate wrack³ and vegetation lines. The vegetation line is assumed to represent the most stable shoreline position of the shorefront while the wrackline is used to characterize the actual dry shoreline position along the upper portion of the intertidal beach. The wrack line may reveal the presence of recent accretion where vegetation has not yet established. Since the photographs represent varying stages of tide, the lines shown are approximate.

A qualitative review of the historical aerial photography and the approximate digitized shoreline positions, indicate three distinct “phases” of shoreline conditions in the vicinity of the Lands End groin between 1951 and present. These phases are bracketed by two significant construction activities: (1) the dredging and armoring of interior portions of Braddock Cove Creek (initial dredging occurred at an undetermined date between 1965 and 1972), and (2) the construction of the Lands End groin and adjacent upland concrete bulkhead sometime between 1975 and 1979.

Between 1951 and 1965, the shoreline south of Braddock Cove Creek generally advanced northward, suggesting, as expected, that net littoral drift along this shoreline is typically from south to north. Likewise, the entrance to Braddock Cove Creek also shifted northward and decreased in width as the channel was apparently forced against the adjacent established marsh to the north. From review of the photographs, it appears that the width of the entrance channel decreased from roughly 180 feet in 1951 to 60 feet in 1965.

Sometime between 1965 and 1972⁴, the interior area of Braddock Cove Creek was dredged to enhance adjacent private development initiatives, reconfigured and significantly widened, by as much as 200 feet. It also appears that the entrance channel to the interior areas was excavated but not widened significantly. Review of the photos also suggest that a rip-rap revetment was constructed along roughly 1,500 feet of the western bank of the excavated lagoon (**Photo 2.1**). The first significant housing development on the Lands End peninsula also appears in the 1972 photograph.

³ The wrack line is the approximate upland extent of a normal high tide, which can often be identified by the line of debris that washes up during each high tide.

⁴ Based upon a review of the available historical photography.

During the same period (1965 to 1972), the Calibogue Sound shoreline south of the entrance advanced significantly -- more than 80 feet at the wrack line. Presumably most of this shoreline advancement was associated, in part, with the placement of dredged material from the excavation and expansion of the interior areas of Braddock Cove Creek.

By 1975, the creek entrance appears to have widened further and interior areas of the lagoon had widened to approximately 300+ feet. Meanwhile, the shoreline in the vicinity of the present groin retreated roughly ± 100 feet relative to the 1972 position. It is unclear if the channel and lagoon widening and shoreline retreat were due to additional dredging of the area or natural equilibration to the new shoreline and creek configuration.

Comparison of the historical photos suggests that the Lands End groin was constructed sometime between 1975 and 1979. It also appears that during this same period, the concrete bulkhead was built along the northern tip of the Lands End peninsula. Construction of these structures may have been in response to the shoreline retreat (1972-1975) and apparent instabilities along the Lands End Calibogue Sound shoreline. These structures appear to have stabilized the upland area behind the bulkhead and shoreline north of the groin. The increased shoreline stability to the south of the groin is evident from review of the vegetation line location to the south of the structure (Figure 4.2). Advances of the vegetation line suggest that the groin was impounding sand along the shoreline to the south. By 1987, the wrack line in the vicinity of the groin had advanced by as much as roughly 90 feet relative to the 1975 pre-groin location.

Throughout the 1980's and 1990's, the shoreline south of the groin continued to advance before stabilizing sometime between 1999 and 2002. This suggests that the groin, as configured, was completely impounded with sand around that time. Thereafter, any material transported to the area was either lost to Calibogue Sound or transported through and/or across the groin to Braddock Cove Creek. **Figure 4.5** depicts the location of the seaward edge of the dry beach berm (+5.0 ft) at monitoring station H00A, relative to the April 1997 location. The station is located approximately 1,150 ft south of the Lands End groin (see Figure 2.1). The figure indicates that except for the period following the offshore passage of Hurricanes Dennis and Floyd in late summer 1999, the shoreline at this location has remained relatively stable since April 1997.

Also during the 1980's and 1990's, there was significant growth in the sand spit north of the groin. This suggests a high sand transport rate past this structure from south to north. It is not known if the high transport volumes past the structure were due principally to the condition of the groin or due to elevated storm conditions during this period. It is likely it was combination of both.

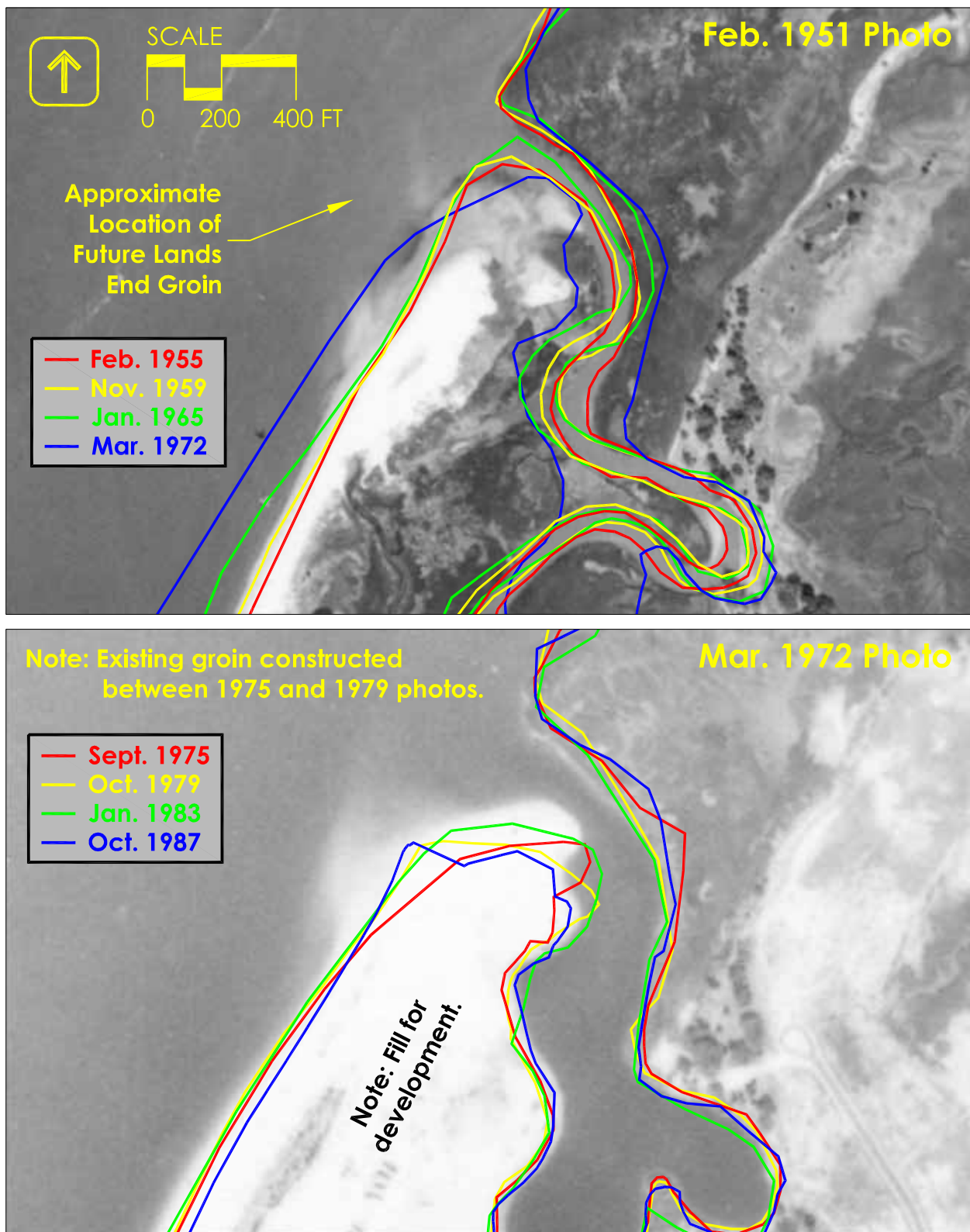


Figure 4.1: Digitized **RACK LINE** position for Lands End groin area (1951 through 1987)

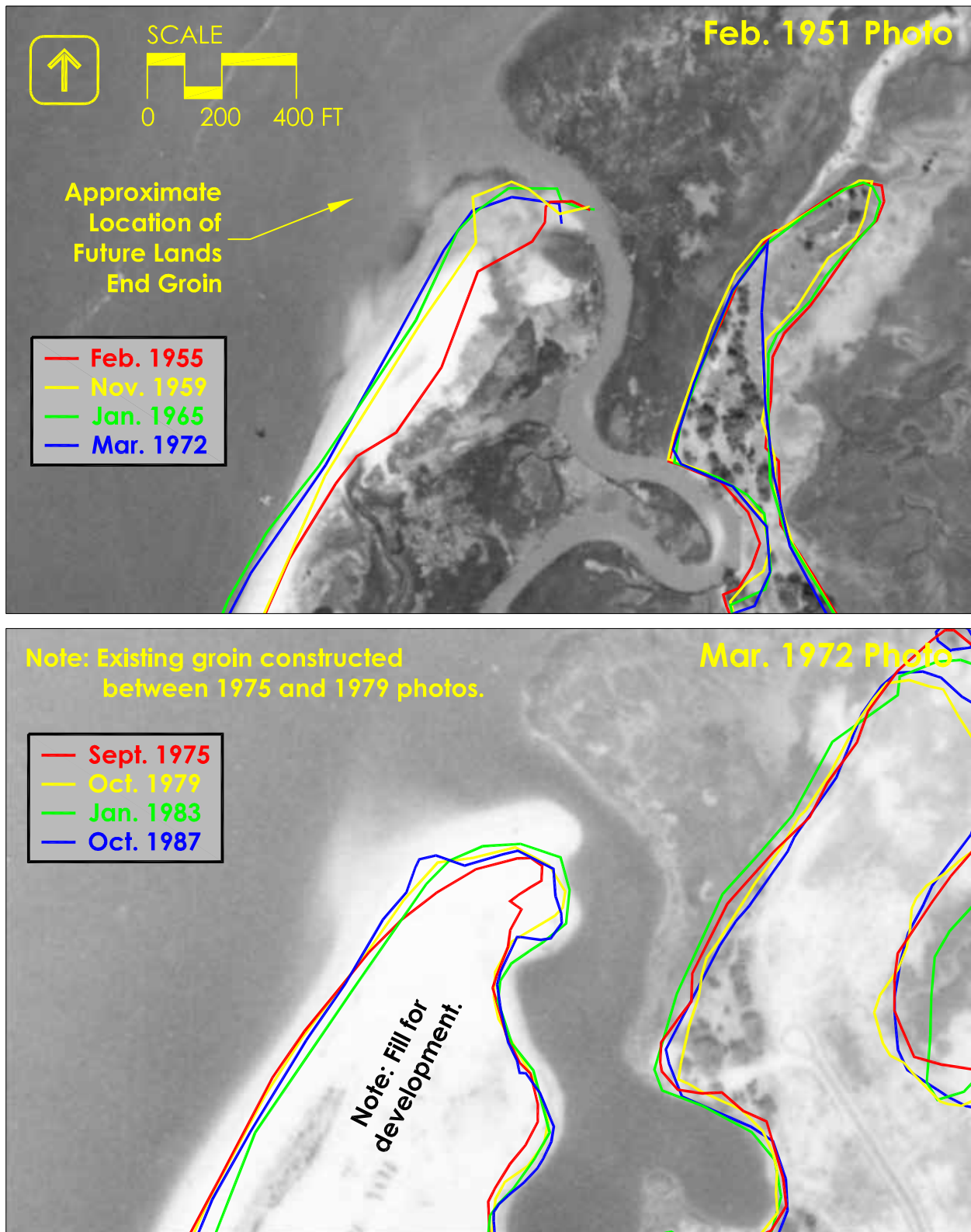


Figure 4.2: Digitized **VEGETATION** position for Lands End groin area (1951 through 1987)

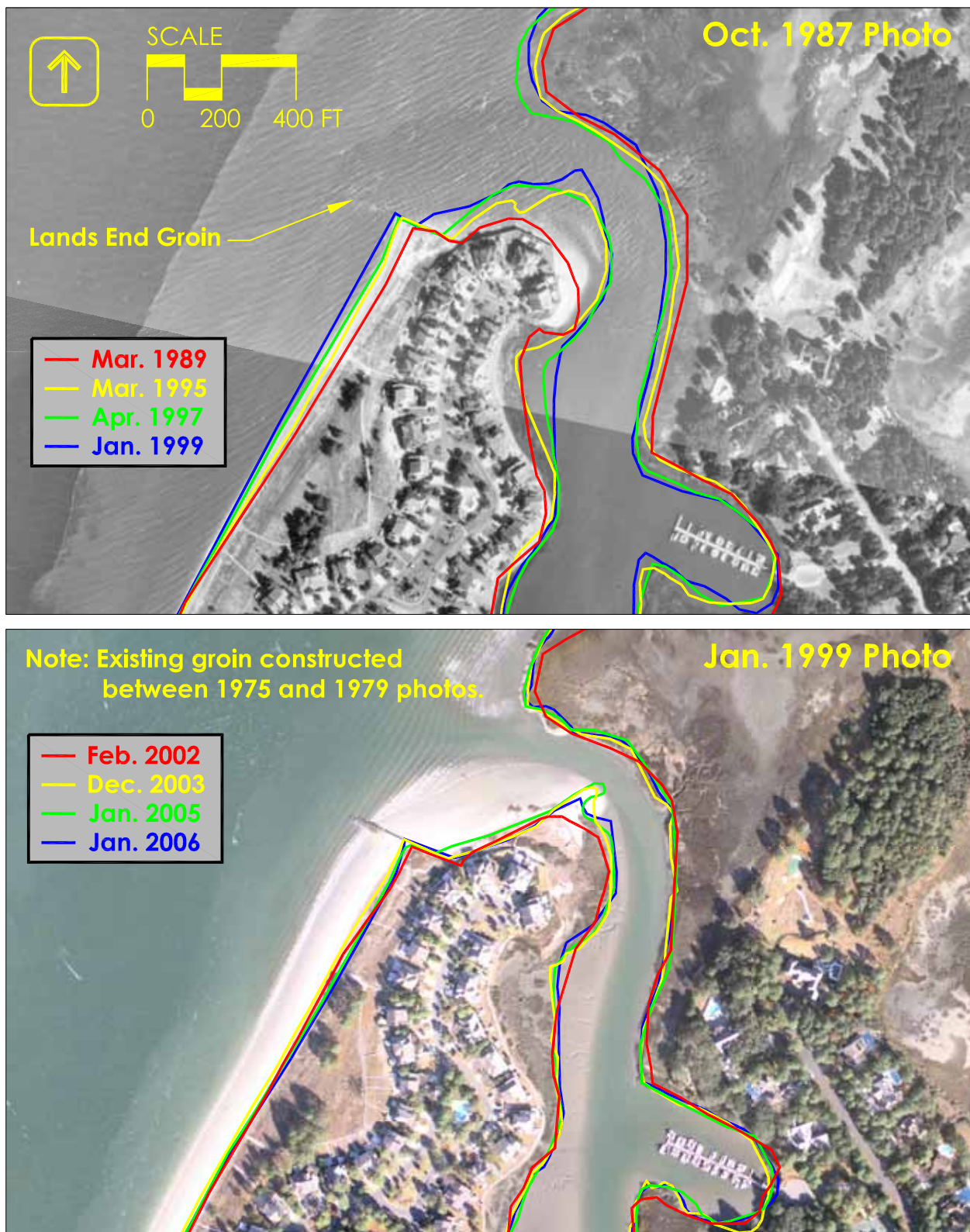


Figure 4.3: Digitized **RACK LINE** position for Lands End groin area (1987 through 2006)

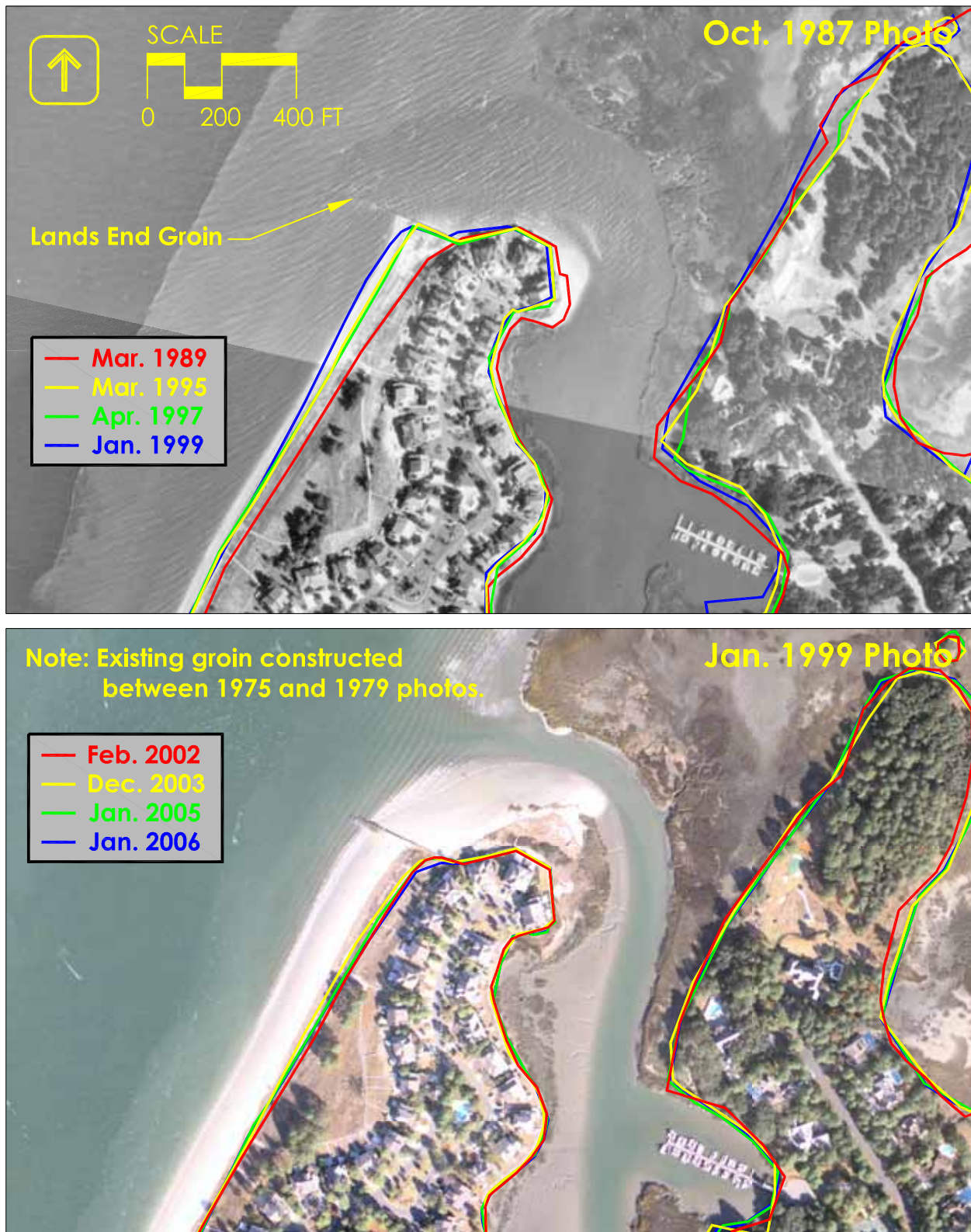


Figure 4.4: Digitized **VEGETATION** position for Lands End groin area (1987 through 2006)

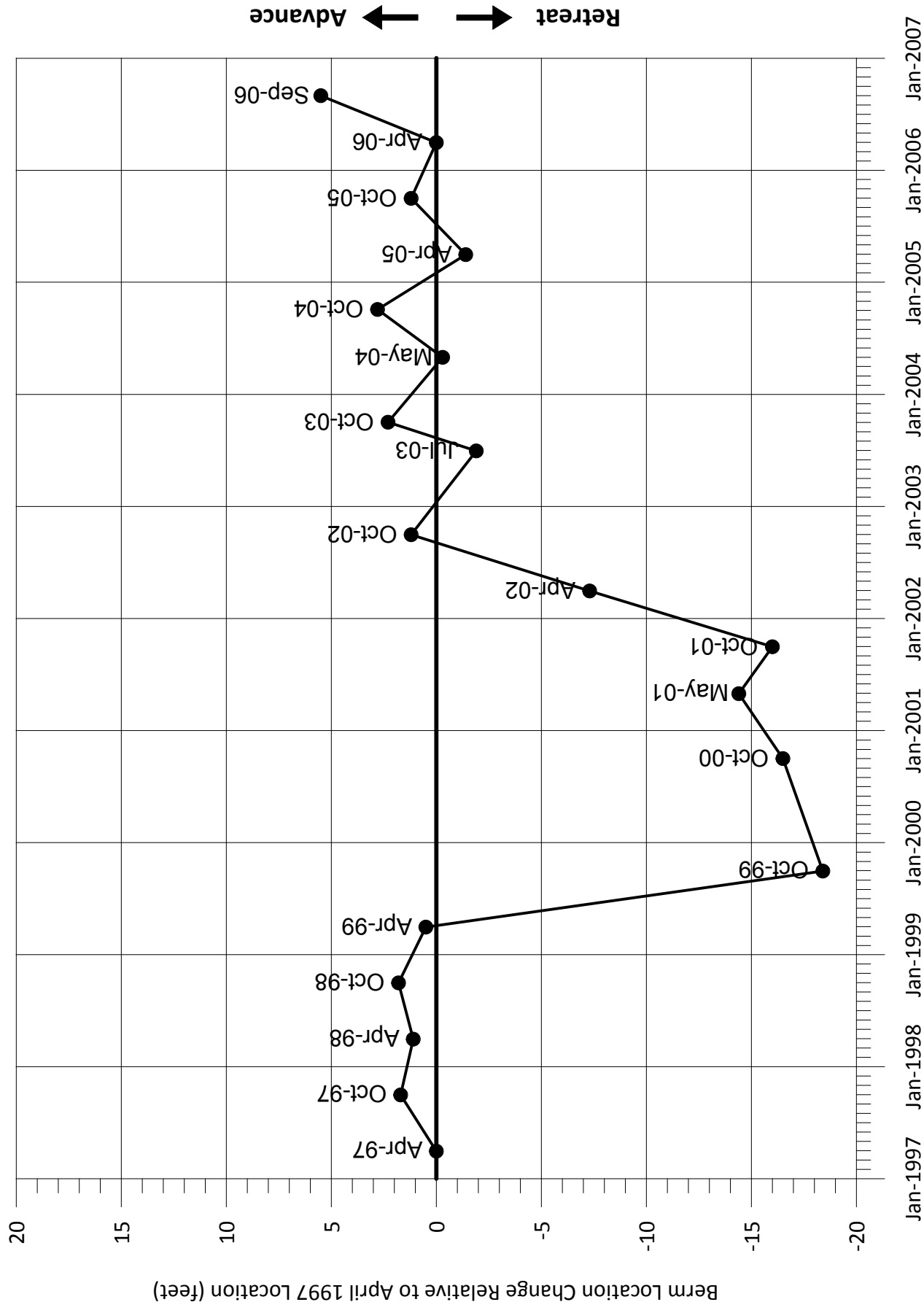


Figure 4.5: Historical location of the seaward edge of the dry beach berm (+5.0 ft) at monitoring station H00A, relative to the April 1997 location (April 1997 to September 2006).

Figure 4.6 summarizes the historical changes in the “wrack” line north of the Land End groin between 1987 and 2006. Comparison of the wrack line delineations demonstrates that the most pronounced change in the size of the spit north of the groin occurred between about 1987 and 1995. Subsequent to 1995, changes in the size of the spit are also evident but the rate of spit growth is reduced significantly compared to that which existed between 1987 and 1995. The continued but slower growth of the spit after 1995 suggests that (1) sand continues to be transported across the Land End groin from south to north and (2) the entrance channel to Braddock Cove may have reached its minimum equilibrium configuration. That is, the tidal flows in and out of the channel are sufficient to maintain a minimum channel area (sf) under the forces of sand accumulation from the adjacent shoreline.

In this configuration, it is expected that size of the spit and the channel are controlled by the tidal scouring and sand that is transported across the groin is distributed across a growing ebb tidal shoal of Braddock Cove Creek. This may explain the present day shallow controlling depths typifying the platform located beyond the narrowest section of the channel and Calibogue Sound. Accordingly, it is likely that the continued transport of sand across the Lands End groin may result in additional sand accumulation across the ebb tidal shoal area of the creek and therefore more restrictive navigable depths. Due to the size of the Braddock Cove lagoon and relatively low sand transport rate to the inlet, it is unlikely that the Braddock Cove entrance channel would close completely, unless a significant storm event impacts the area and transports material from the spit into the controlling area of the channel at a high rate.

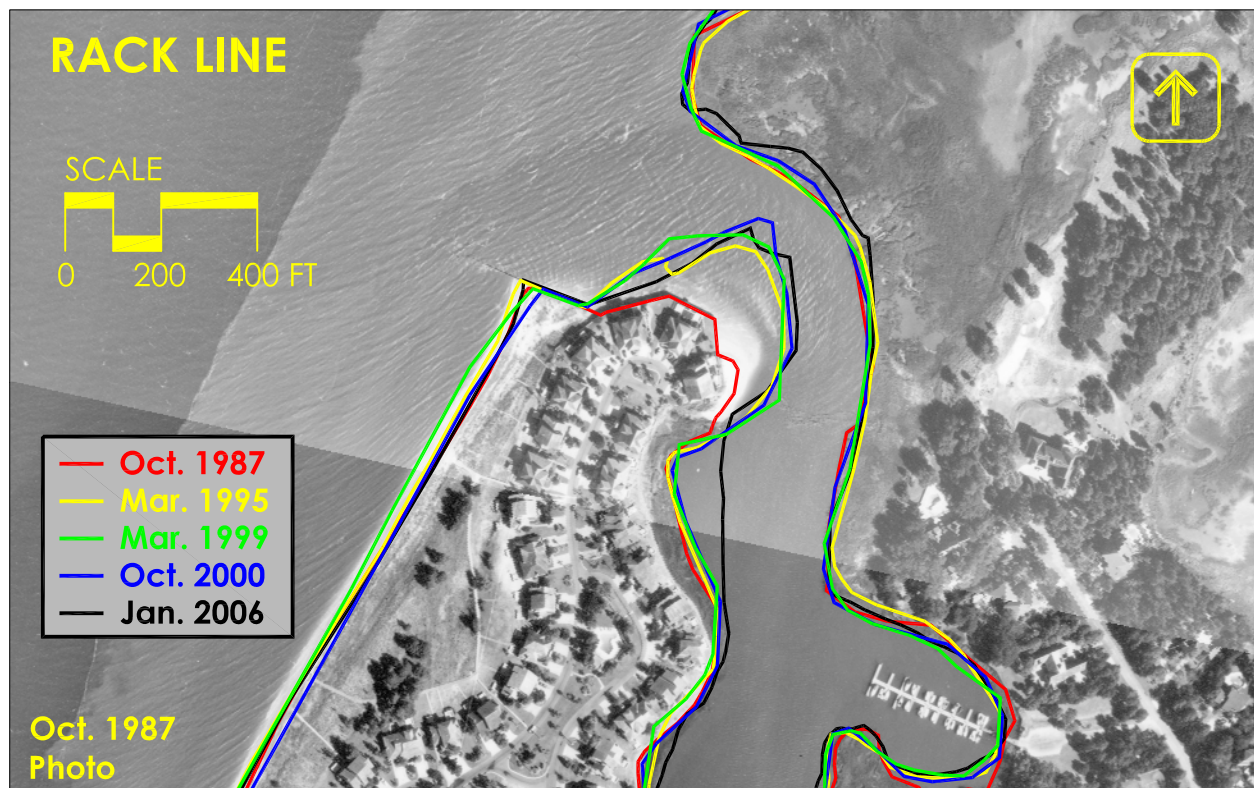


Figure 4.6: Digitized **RACK LINE** position for the Lands End groin area (1987 to 2006)

5.0 ENGINEERING ALTERNATIVES

Given the current condition of the Land End groin and absent intervention, continued sand transport across and through the structure is expected to continue. This may limit the stability of the updrift shoreline and may result in continued spit growth, sediment pressure on the inlet channel, and a further reduction in the navigability of the inlet. The most effective method to impound sand along the shoreline south of the groin and to control the transport of sand to the north of the groin is to modify the configuration of the structure and direct sediment delivered to the area to the deeper waters of Calibogue Sound seaward of the inlet. This reduction in sand transport across and through the Lands End groin would further stabilize the shoreline to the south and reduce the rate of spit and shoal development north thereof. The latter, over time, could potentially result in improved navigability of the Braddock Cove Creek Entrance.

To increase the rate of sand capture at the groin, the permeability of the structure must be reduced. This is typically accomplished by sand-tightening and increasing the effective height of such a structure. Several options that may be considered to improve the sand retention capacity of the Lands End groin and correspondingly reduce the rate of sand transport past this structure are outlined in the following discussion.

5.1 No-Action Alternative (Option 1)

While it is understood that the Town intends to address the deteriorated condition of the Lands End groin, the no-action approach is discussed in order to define the expected future changes to the area if a comprehensive enhancement project is not pursued. The no-action alternative would allow the continued passage of sand through and over the top of the groin. Without maintenance, the transport rate past the structure would be expected to further increase as the groin continues to deteriorate. If this is allowed, the presently available recreational beach area south of the groin may decrease as more sand is lost to the creek entrance and the southern shoreline receded in response to the groin condition. Additionally, the southern bank of the Braddock Cove Creek entrance may continue to grow, potentially reducing the navigability of the creek entrance.

5.2 Restore Existing Structure to Original Design Configuration (Option 2)

The restoration of the groin to its original design condition would require that all damaged timber panels be replaced. The new panels would need to be locked in place with new chocks. Chocks are wood blocks which are thru-bolted to the top of the king piles for the

purpose of locking the timber panels in place. Potentially some of the king-piles may need to be replaced, however based upon a limited survey of the structure it appears the all of the king-piles are in reasonable condition. If replacement king-piles are needed, they would have to be specially manufactured which could, in turn result in significant cost. The length of the existing king-piles is unknown – but assumed adequate.

Potential Effects. By restoration to its original design condition, the structure's effectiveness as a sand barrier would be significantly improved. However, since the original design elevation typically falls below the adjacent beach elevations, it is highly likely that sand will continue to escape over the top of the structure and beach stability may be compromised.

Opinion of Probable Cost to Construct. Without a more comprehensive investigation of the groin, which would involve complete excavation of the proposed work area, the exact number of timbers required and condition of the king-piles cannot be accurately determined. However for planning purposes, it is expected that the probable cost to repair the groin would not exceed \$25,000 (more or less) – assuming all existing king-piles are in reasonable condition. This does not include costs for the frequent future maintenance work anticipated due to the nature of a timber structure in a dynamic marine environment.

Permits. Because the repairs would not modify the groin's original configuration, specific permits from the State of South Carolina and U.S. Army Corps of Engineers would likely not be required. Limited coordination with the agencies in regard to the scope of the repair would be recommended to ensure that the proposed activity is viewed only as maintenance by the State and Federal regulatory agencies.

5.3 Sand-Tighten, Elevate and Armor Existing Structure (Option 3)

A comprehensive and effective solution for controlling and reducing sand transport across the Lands End groin would be to sand-tighten and armor the existing structure to an elevation above the anticipated natural beach grade. **Figures 5.1 and 5.2** depict the concept of an armored, elevated and sand-tightened groin. The groin would be armored with 1 to 2 ft rip-rap (similar to Class D, AASHTO Rip-Rap) and sand-tightened using an internal membrane of a geogrid/fabric composite. The structure would be sand-tightened to an elevation of at least +9.0 ft-NGVD. An optional marine mattress underlayer could be considered on the north side of the structure, to minimize differential settling of the armor stone over time. Lowering of the existing sand elevations on the north side of the groin would be expected after the structure is reconstructed.

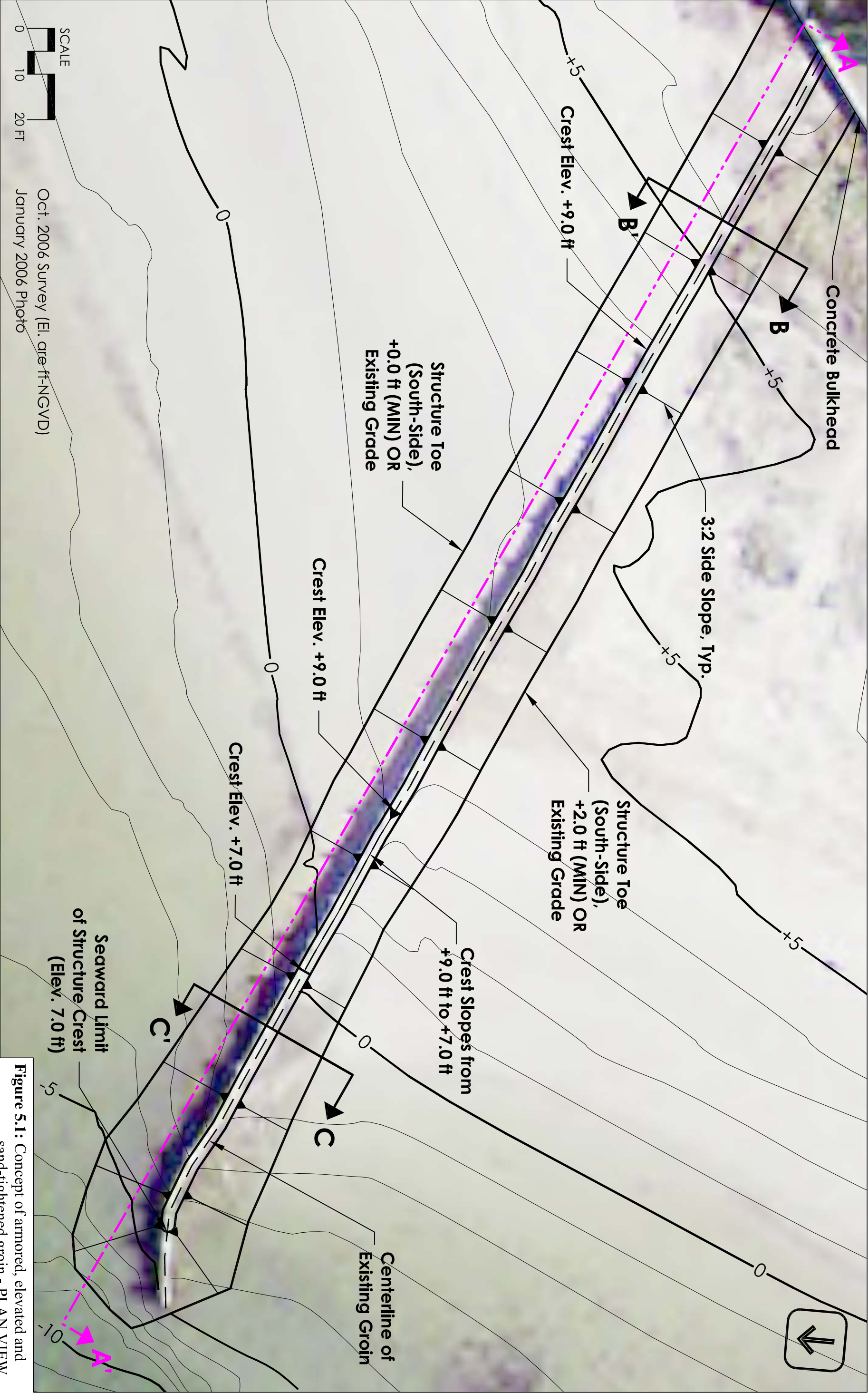
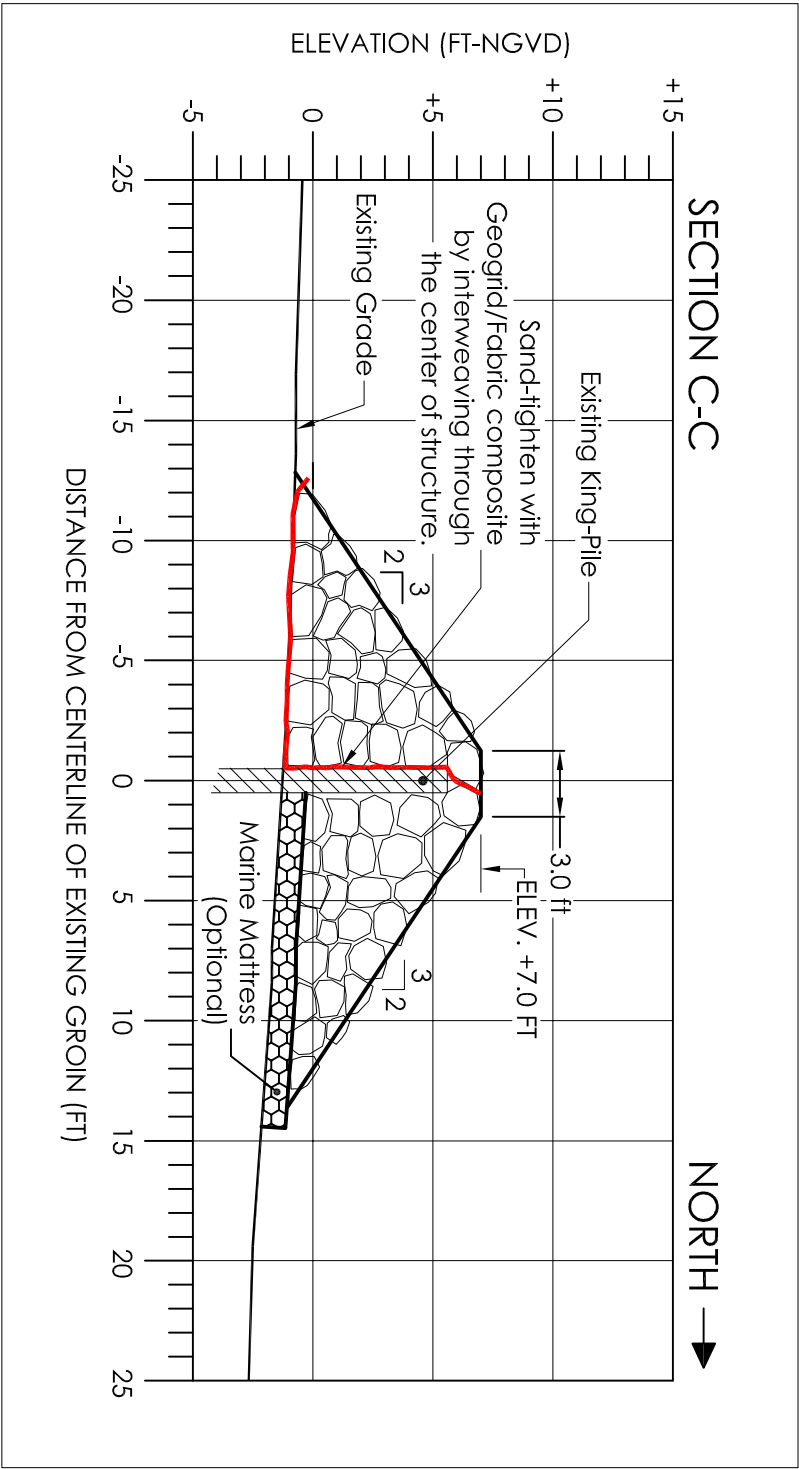
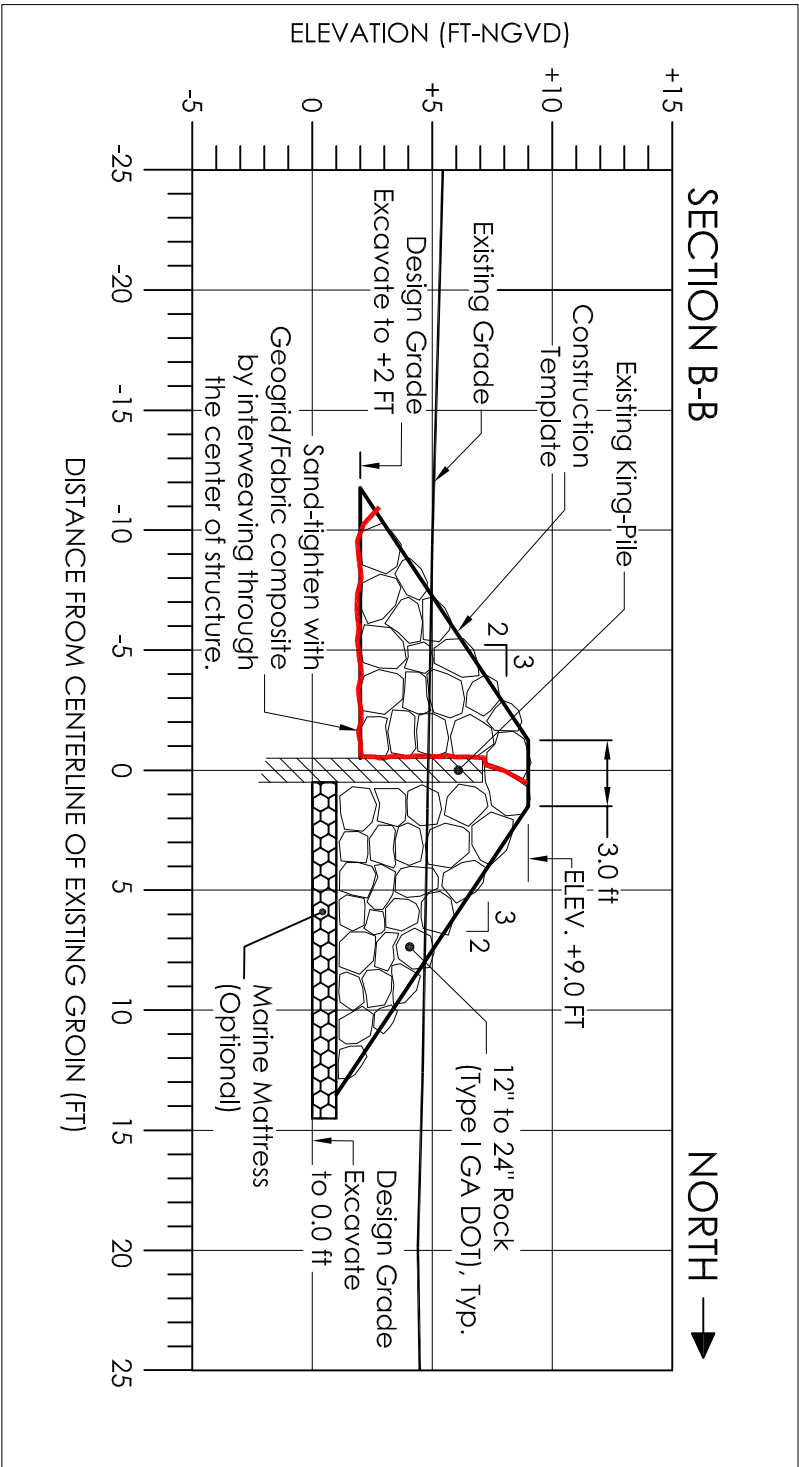
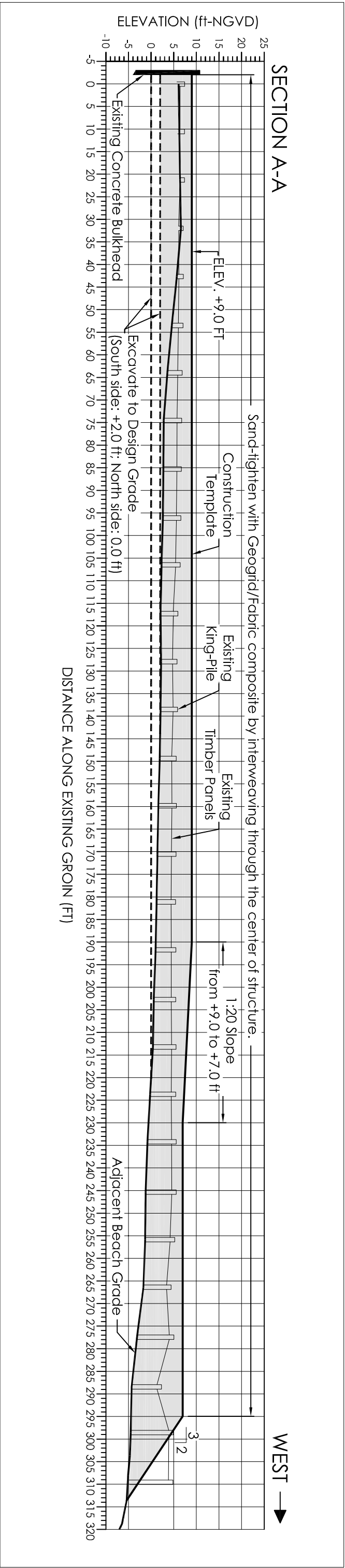


Figure 5.1: Concept of armored, elevated and sand-tightened groin - PLAN VIEW.
(see Figure 5.2 for SECTIONS).



Oct. 2006 Survey (E. are ft-NGVD)

Figure 5.2: Concept of armored, elevated and sand-tightened groin - SECTION VIEW. (see Figure 5.1 for PLAN VIEW).

Potential Effects. By sand-tightening and elevating the structure, its effectiveness as a sand barrier will increase. As such, it is reasonable to assume that following construction, the beach immediately south of the structure will begin to accumulate additional sand. Meanwhile, the quantity of sand bypassing the groin will be significantly reduced, thereby decreasing the amount of sand entering the Braddock Cove Creek entrance. Any excess sand transported to the groin would be expected to pass around its seaward end to the deeper waters of Calibogue Sound instead of the Braddock Creek entrance. As a result, the entrance to the creek may widen. Assuming a constant equilibrium cross-sectional area and hydraulic efficiency at the creek's entrance, the average depth of the entrance would consequently decrease, potentially impacting the navigability of the deeper area of the creek channel. The depth of the ebb tidal shoal, which is the most restrictive to navigation in and out of the channel, may not be adversely affected. Rather, a reduction in sand supply past the groin may ultimately result in a general lowering of the ebb shoal structure. The timing and extent of any natural shoal lowering cannot be estimated with the information included in this analysis.

Additionally, the reduction in the amount of sand bypassing the structure may result in the recession of the shoreline adjacent to the concrete bulkhead, immediately north of the groin. From the available historical photography, it appears that in the past, the shoreline has receded to the base of the bulkhead (Appendix A: Oct. 1987 and March 1989 photographs). It is anticipated that the degree of bulkhead exposure following the proposed groin improvements would not exceed the historical levels shown in the aerial photography. However, as the original design and existing condition of the concrete bulkhead are presently unknown, the effect of a return to the historical shoreline exposure at the structure is unable to be determined at this time. It is assumed that the wall was designed to be sufficiently stable under the late 1980's conditions. If following construction of the proposed groin improvements, the degree of shoreline retreat is unacceptable, shore stabilization of the beach north of the groin could be considered.

Opinion of Probable Cost to Construct. The details of the opinion of the probable cost to construct this option with and without marine mattresses are summarized in **Tables 5.1** and **5.2**, respectively. Since access to this site from the upland is limited, it is likely that all equipment and materials would be best mobilized from the water side. Accordingly, expected unit cost for materials may be higher than those typical for similar work with reliable upland access. An allowance has been made for this in the opinion of probable cost to construct.

In sum, the opinion of the probable cost to construct, assuming a 15 percent contingency, is \$ 613,010 with marine mattresses and \$ 608,180 without marine mattresses. This does not include the cost for permitting, engineering, surveying, design, construction oversight, and possible post-construction monitoring.

Permits. Since the proposed action will expand the structure beyond its originally constructed configuration, both State and Federal permits will likely be required. Depending upon issues raised by the resource and regulatory agencies and considering the typical time required by the State and Federal regulatory agencies to process a permit file, a reasonable schedule to obtain permits would be 6 to 9 months from the time an application is submitted. A more expeditious permitting schedule will be pursued but should not be considered in project construction planning.

Table 5.1: Probable cost⁵ to sand-tighten, elevate and armor existing structure - Option 3 (with marine mattresses).

No.	Item	Unit	Qty.	Unit Cost	Unit Total
1	Mobilization	JOB	1	\$50,000	\$50,000
2	Excavation	CY	510	\$10	\$5,100
3	GA DOT Type I Rip-Rap	TONS	2,550	\$150	\$382,500
4	Marine Mattress	SQFT	5,300	\$12	\$63,600
5	Geogrid/Fabric Composite	SQFT	9,100	\$3.50	\$31,850
<i>Estimated Subtotal</i>					\$533,050
<i>Contingency (15%)</i>					\$79,960
Total Project Cost					\$613,010

Table 5.2: Probable cost⁵ to sand-tighten, elevate and armor existing structure – Option 3 (no marine mattresses).

No.	Item	Unit	Qty.	Unit Cost	Unit Total
1	Mobilization	JOB	1	\$50,000	\$50,000
2	Excavation	CY	460	\$10	\$4,600
3	GA DOT Type I Rip-Rap	TONS	2,800	\$150	\$420,000
4	Geogrid/Fabric Composite	SQFT	15,500	\$3.50	\$54,250
<i>Estimated Subtotal</i>					\$528,850
<i>Contingency (15%)</i>					\$79,330
Total Project Cost					\$608,180

⁵ Since this work will likely be constructed from a water based mobilization, expected unit cost for materials may be higher than those typical for similar work with reliable upland access. An allowance has been made for in the probable cost to construct.

6.0 SUMMARY

The Lands End shoreline and Braddock Cove Creek on Hilton Head Island have been highly manipulated since the 1960's as a result of the development of that area. The construction of the Lands End groin and adjacent upland concrete bulkhead was likely intended to stabilize the shoreline immediately south of the entrance of Braddock Cove which was principally on artificially created upland. The structure has been generally effective as evidenced by the creation of the extensive sand impoundment fillet south of the structure and historically stable upland.

In the recent past, however, the Lands End groin has not been completely successful in controlling all sediment delivered to the structure by the naturally occurring south to north littoral drift. As a result, sand has been transported over and through the groin which has resulted in the creation of a depositional spit to its north. The most significant growth of the spit appears to have occurred between 1987 and 1995 (see summary of historical photos in Appendix A). The development and presence of the depositional feature has shoaled the entrance channel to Braddock Cove and adversely affected navigability. Likewise, continued sand transport across the groin that is not stored in the sand spit appears to have contributed to the development of an ebb tidal shoal at the creek entrance. It is this shoal feature that has most significantly affected navigability in and out of the creek -- at low tide conditions. Recent efforts by CSA to repair and maintain the Lands End groin in its original configuration have not resulted in a notable decrease in the amount of sand that gets past the structure. More comprehensive improvements to the Lands End groin that reduce the amount of sand bypassing at this location could further stabilize the beach to the south and limit the amount of sand that is delivered to the inlet channel and adjacent seaward shoals.

An approach is proposed in this report to repair and/or improve the Lands End groin configuration. Such a modification would sand-tighten the structure and increase its effective elevation -- both of which would significantly reduce the amount of sand transported directly to Braddock Cove Creek. Conversely, additional sand may accumulate along the shoreline south of the groin and any excess sand would likely be transported past the end of the structure to the deeper areas of Calibogue Sound rather than the navigable areas of Braddock Cove Creek.

In summary, greater control of sand transport over, through, and around the existing groin structure would benefit both the beach to the south (i.e., increased stability and potential additional shoreline advance) and the tidal creek (i.e., reduced shoaling potential). Furthermore, any future navigation improvements to the Braddock Cove Creek entrance (i.e., maintenance dredging or stabilizing structures) would benefit from the proposed modifications to the groin via some reduced potential for reshaling.